Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Discussion on MIMO Spatial Multiplexing For E-MBS**
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Re:	IEEE 802.16m-08/005, “Call for Contributions on Project 802.16m System Description Document (SDD)”. Target topic: “Pilot Structures as relevant to downlink MIMO ”
Abstract	The contribution proposes spatial multiplexing for E-MBS, and also raises several discussion points related to spatial multiplexing E-MBS. One discussion point is the possibility of improving system capacity of spatial multiplexing MBSFN by utilizing SFN characteristics. Another discussion point is the necessity of increasing pilot density of spatial multiplexing MBSFN.
Purpose	To be discussed and adopted by TGm for the 802.16m SDD
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Discussion on MIMO Spatial Multiplexing For E-MBS

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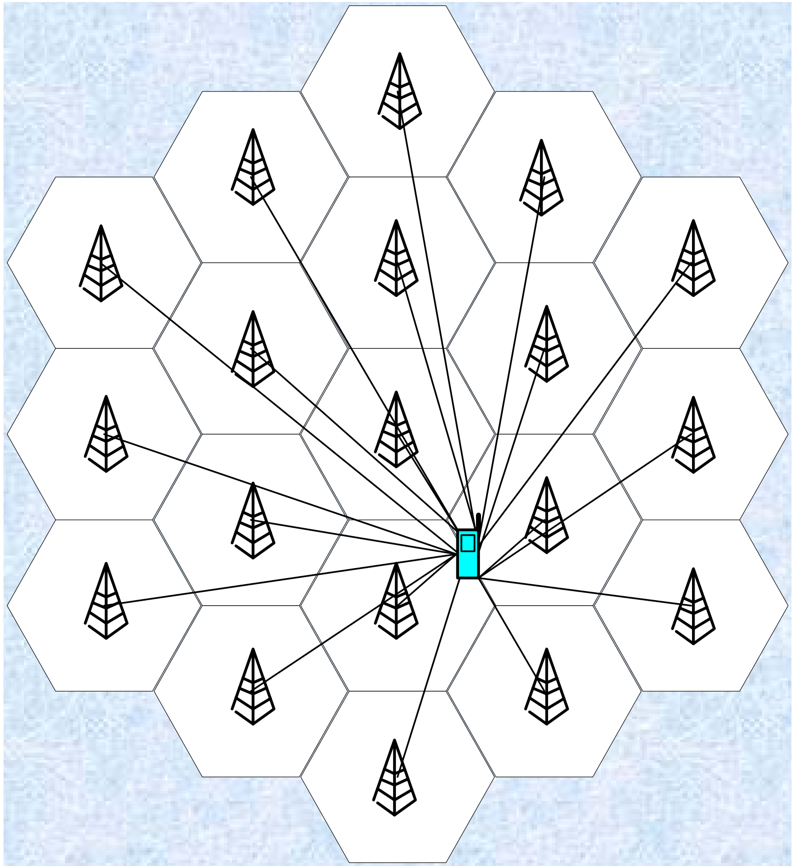
10 March, 2008

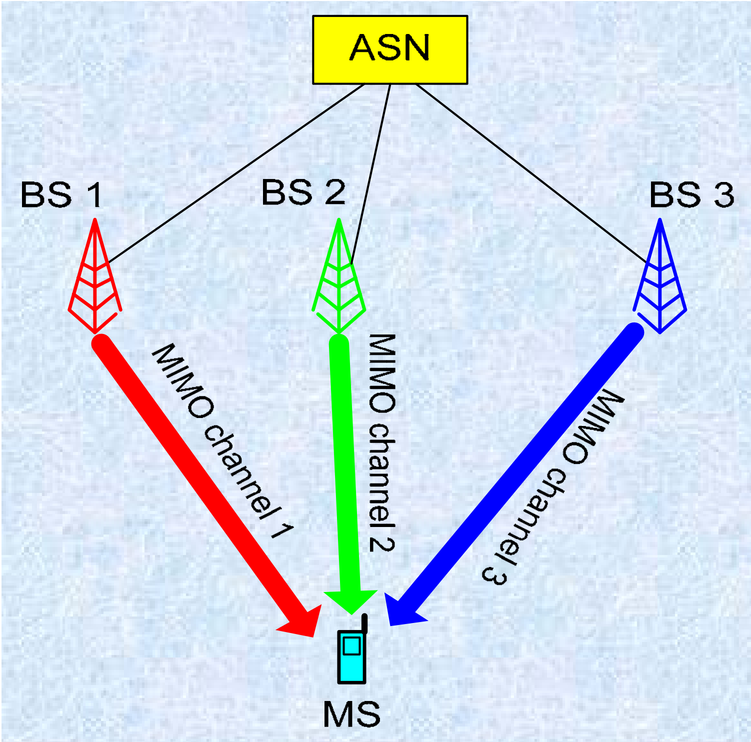
Introduction

- E-MBS requirement in 16m SRD
  - 16m shall provide for an E-MBS, providing ***enhanced multicast and broadcast spectral efficiency***
  - The performance requirements apply to a wide-area ***multi-cell multicast broadcast single frequency network*** (***MBSFN***)
- MBSFN
  - Multiple cells form a MBS zone
  - The same information is transmitted simultaneously from all cells in the MBS zone
  - A MS may receive signal from all cells in the MBS zone so that the SINR may be improved
  - ***Fast feedback signalling from the MS may not be feasible***



MIMO for MBSFN

- The following three MIMO techniques may be considered by E-MBS to enhance its spectral efficiency
  - Transmit diversity, e.g., Matrix A for 2 Tx antennas in 16e;
  - Spatial multiplexing, e.g., Matrix B for 2 Tx antennas in 16e
  - A hybrid of both, e.g., Matrix C for 2 Tx antennas in 16e
- However, any form of transmit diversity may not bring significant benefits due to rich frequency diversity inherent to MBSFN



Spatial multiplexing may be a viable option for MBSFN

MIMO Spatial Multiplexing for MBSFN

- Spatial Multiplexing (SM)
  - A MIMO transmission technique to transmit independent data streams from each of the multiple transmit antennas. Different data streams may have different robustness levels, e.g., different power levels, different MCS
  - SM is optimal when the SINR is high
  - SM would work better as channels are less spatially correlated
  - Feedback based on long-term statistics may be necessary
- Why Spatial Multiplexing is for MBSFN?
  - SM is already defined as a MIMO mode for unicast in 16e
  - In MBSFN, the delayed signals received from multiple cells can be combined at a MS to improve the SINR
  - The signals received from multiple cells sees increasing decorrelation
  - ***It has been shown via simulations in various LTE contributions [2-5] that SM can significantly improve the MBSFN performance, especially in urban scenario where the cell size is relatively small***.

We promote spatial multiplexing as a transmission mode for E-MBS

System Capacity Loss for Spatial Multiplexing MBSFN due to Antenna Correlation

- *System capacity for SM MBSFN decreases with the increasing of antenna correlations*
- Assumed scenario for SM MBSFN
  - Five BSs, each with two Tx antennas, and one MS with two Rx antennas
  - Three antenna correlation cases are considered:
    - Case 1: no antenna correlation at BSs and MS
    - Case 2: antenna correlation at each BS is 0.3, that at MS is 0.6
    - Case 3: antenna correlation at each BS is 0.7, that at MS is 0.9
  - The received signal at the MS

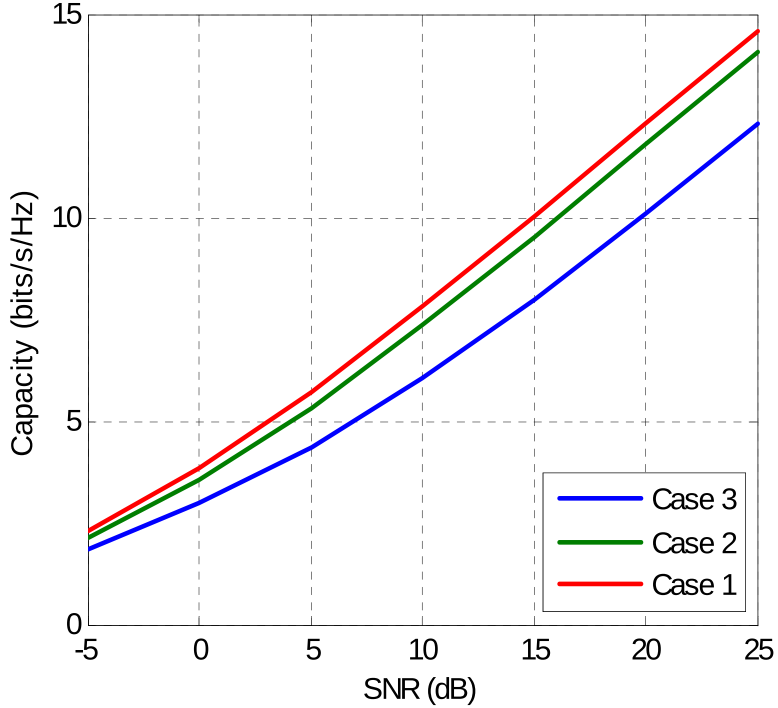
$$\mathbf{r} = \mathbf{B}(\mathbf{H}_1\mathbf{A}_1+\mathbf{H}_2\mathbf{A}_2+\mathbf{H}_3\mathbf{A}_3+\mathbf{H}_4\mathbf{A}_4+\mathbf{H}_5\mathbf{A}_5)\mathbf{s} + \mathbf{n}$$

$$\mathbf{A}_1=\mathbf{A}_2=\mathbf{A}_3=\mathbf{A}_4=\mathbf{A}_5=\mathbf{A}$$

$\mathbf{A}_i$: square root of antenna correlation matrix of i^{th} BS

$\mathbf{H}_i$: i.i.d channel matrix between i^{th} BS and MS

$\mathbf{B}$: square root of antenna correlation matrix of MS



- Capacity calculation

$$C = E\left[\log\left|\mathbf{I} + SNR \bullet \mathbf{H}_c\mathbf{H}_c^H\right|\right]$$

$$\mathbf{H}_c = \mathbf{B}\,(\mathbf{H}_1+\mathbf{H}_2+\mathbf{H}_3+\mathbf{H}_4+\mathbf{H}_5)\mathbf{A}$$

System Capacity Improvement for Spatial Multiplexing MBSFN

❑ Discussion Point

Is it possible to improve system capacity of MIMO MBSFN by utilizing SFN characteristics to compensate system capacity loss due to antenna correlation?

Conclusion

- Spatial multiplexing MBSFN suffers system capacity loss due to antenna correlation. One interesting discussion point is the possibility of improving system capacity of spatial multiplexing MBSFN by utilizing SFN characteristics to compensate system capacity loss due to antenna correlation.
- Another interesting discussion point is the necessity of increasing pilot density of spatial multiplexing MBSFN.

References

1) IEEE 802.16m-07/002r4, IEEE 802.16m system requirement
2) 3GPP R1-072763, Spatial multiplexing for MBSFN, Nortel, Jun 2007.
3) 3GPP R1-073298, Further Discussion on Spatial Multiplexing for MBSFN, Nortel, Aug 2007.
4) 3GPP R1-073398, MBSFN performance with SFBC and spatial multiplexing, Motorola, Aug 2007.
5) 3GPP R1-073975, Evaluation of Spatial Multiplexing for MBSFN Including Line of Sight Considerations, Nortel, Oct. 2007.

Proposed Text to 16m SDD (802.16m-08/003)

- Insert the following text in Chapter 15 (Support for Enhanced Multicast Broadcast Service)

Spatial multiplexing is already chosen as a MIMO mode for unicast transmission in IEEE 802.16e. Spatial multiplexing should be adopted in 16m as a transmission mode for MBSFN for the purpose of providing support of enhanced multicast/broadcast spectral efficiency.